Gesellschaft Catalogue were measured together with Jupiter, and the position of Jupiter deduced with reference to them.

It will be observed that the deduced place of Jupiter will be affected by the systematic error of the Catalogue, and the error due to unknown proper motions, and for that reason it is directly comparable with the positions of the satellites deduced in the same manner.

Five photographs were selected for measurement, and the results are given below.

*Errors of Tabular Place* (T – O).

| 1907. | R.A. | Dec. |
|---|---|---|
| | s | " |
| Feb. 28 | – ·06 | +0·2 |
| Mar. 1 | – ·06 | +0·4 |
| 1 | – ·05 | – 0·2 |
| 20 | – ·05 | – 0·7 |
| 21 | – ·07 | +0·1 |
| Mean | – ·058 | – 0·04 |

The photograph on March 20 is unsatisfactory.

The tabular place is taken from the *Nautical Almanac.*

*Royal Observatory, Greenwich:*
1907 *May* 10.

---

## *Note on the Spectrum of α Orionis.* By H. F. Newall and B. Cookson.

### *Titanium Flutings in the Red End of the Spectrum of α Orionis.*

A photographic study of the red end of the spectrum of some of the brighter stars has been made during the past two months at the Cambridge Observatory with a four-prism spectrograph attached to the 25-inch refractor. It has led to the discovery, amongst other things, of a marked feature in that part of the spectrum of *α Orionis*, viz. three strong flutings, which in this note are interpreted as absorption flutings, with heads towards the blue end. Only a preliminary determination of the wave-lengths of these heads has been made; for, on account of the paucity of lines in the spark spectrum of iron, which has been used as a comparison spectrum, some uncertainty—to the extent of about 2 tenth metres—is attached to the identification of a red line near 7155, which has been used as one of the reference lines.

This line 7155 and the stellar flutings are in truth outside of the range of spectrum, for which the four-prism spectrograph had

been adjusted, and the definition is not what it ought to be for a careful determination of wave-length.

However, the interest of the matter lies in the facts (i) that the provisional values deduced for the wave-lengths of the heads of the flutings are—

7053
7087
7124

and (ii) that Hale and Adams have in their paper (*Astroph. Jour.*, xxv., 77) given the wave-lengths of three absorption flutings which they have found in the spectrum of Sun-spots, and have identified with bright flutings found by them in the spectrum of the flame of the titanium arc, with heads at wave-lengths—

7054·6
7088·0
7125·9

Thus a chain of evidence seems to be completed:—

(*a*) Professor Fowler discovers many flutings in the flame of the titanium arc and points out the close resemblance, in position and intensity, between these bright flutings and the absorption flutings seen in stellar spectra of type III. (like *α Orionis*).—(*Proc. R.S.* lxxiii. 219.)

(*b*) Messrs Hale and Adams have proved the close resemblance between those features which distinguish both Sun-spot spectra and the spectrum of *α Orionis* from the solar spectrum, viz. certain lines which are present in both Sun-spots and *α Orionis*, with intensity accentuated relatively to the corresponding solar lines (*Astroph. Journ.*, xxiii. 400). (Some further evidence on this point is given in the later paragraphs of the present note; it tends to support the contention of Messrs Hale and Adams.)

(*c*) Messrs Hale and Adams, in their latest note (*Astroph. Jour.*, xxx. 77) on Sun-spot spectra, announce that they have been able to identify flutings in the Sun-spot spectrum as reversals of the bright flutings at the red end of the spectrum of the flame of the titanium arc.

(*d*) The object of the present note is to announce that these dark flutings have been detected in photographs of the red end of *α Orionis*.

Attempts have been made to detect these red flutings in *β Geminorum* and *α Boötis*; but the material so far collected is not quite good enough to establish their presence or absence with complete certainty.

*Sun-spot Lines in the Green Region of the Spectrum of α Orionis.*

Three photographs of the green region of the spectrum of *α Orionis* were taken by Mr H. J. Bellamy in January 1905 with a four-prism spectrograph. They have been recently measured by

Mr W. H. Manning, and the measures have been discussed with a view to seeing whether the lines which were relatively stronger in *α Orionis* than in the Sun were Sun-spot lines. The regions covered are as follows :—

| Plate No. | Date 1905. | Limits of Spectrum studied. |
|---|---|---|
| Fmg. 680 | Jan. 13 | 5098–5328 |
| Fmg. 684 | Jan. 14 | 5108–5324 |
| Fmg. 696 | Jan. 27 | 5341–5521 |

Within these regions many dark (absorption) lines were measured, and also some apparently bright (emission) lines, though it was difficult to say whether these latter were really bright lines or only bright interstices of continuous background between dark absorption lines.

The wave-lengths of all the lines measured are given in the table below. They have been corrected for velocity: up to and including 5328·28 the tabulated values are in general the means of the two plates Fmg. 680 and Fmg. 684; the rest are from Fmg. 696. The scale of the original photographs is 1 mm. = 25 Ångström units.

Photographs of this region of the spectrum of the Sun and of Sun-spots were taken last summer, and it was thus possible to compare the star lines with solar lines and see whether they were lines that were intensified in spots. The results of comparison with three different photographs of Sun-spot spectra (Nos. R.S. 187, 188, 189) are given in the table. A cross (×) indicates that the line was relatively stronger in the spot than in the Sun; o that it was not; ? that intensification in the spot was doubtful. Unfortunately there is a gap in our series of photographs of Sun-spot spectra between 5341 and 5600.

A list of Sun-spot lines was published in *Astroph. Jour.*, xxiii. 15–27, by Hale and Adams, and the fourth column shows those lines which are included in their list, and are considered by them as lines affected in spots.

This table shows clearly that a large number of the star lines are also spot lines. The following lines are almost certainly not spot lines:

All the bright lines marked B.
Lines 5133·61, 5145·44, 5273·21.

The so-called bright lines cannot be identified for certain: it was thought they might be reversals of the Sun-spot fluting of which the wave-lengths are given in *M.N.*, Dec. 1906, but this view has not been upheld. It seems probable that they are not really bright lines.

The other three are not well-marked lines:

5133·61 is very faint and hazy.
5145·44 is fairly strong but very hazy on the red side.
5273·21 is extremely faint.

The last four lines in the table are not very well seen on the

*Wave-Lengths of Lines in α Orionis.*

| α Orionis λ in star. | Sun-spot Lines: R.S. 187. / R.S. 188. | Sun-spot Lines: R.S. 189. | Sun-spot Lines: Hale and Adams. |
|---|---|---|---|
| 5099·10 * | × | | o |
| 5107·72 | × | × | o |
| 5110·56 | ? | × | × |
| 5123·71 | ? | × | × |
| 5127·75 | o | × | ? |
| 5133·61 * | o | o | o |
| 5135·66 *B | | | |
| 5137·20 | o | o | × |
| 5138·23 B | | | |
| 5139·44 * | ? | ? | × |
| 5140·86 *B | | | |
| 5143·03 | × | ? | o |
| 5144·32 B | | | |
| 5145·44 | ? | ? | o |
| 5147·82 | × | × | × |
| 5169·12 * | ? | ? | × |
| 5190·29 *B | | | |
| 5203·62 | o | × | o |
| 5208·59 | × | ? | × |
| 5210·52 | × | × | × |
| 5219·93 | × | × | o |
| 5227·30 | ? | × | × |
| 5228·93 B | | | |
| 5230·25 | × | × | × |
| 5231·64 *B | | | |
| 5247·31 | × | × | × |
| 5250·40 | o | × | × |
| 5255·27 | × | × | × |
| 5264·22 | × | × | × |
| 5265·21 * | o | × | × |
| 5266·28 | × | ? | × |
| 5267·91 B | | | |
| 5269·92 | ? | ? | × |
| 5273·21 * | ? | ? | o |
| 5275·56 * | × | × | × |
| 5300·75 | × | | × |
| 5324·32 * | ? | o | × |
| 5328·28 | ? | | o |

| α Orionis λ in star. | Hale and Adams. |
|---|---|
| 5341·17 | × |
| 5371·80 | × |
| 5395·01 | × |
| 5397·23 | × |
| 5406·04 | × |
| 5409·94 | × |
| 5429·92 | × |
| 5434·91 | o |
| 5447·08 | × |
| 5455·95 | o |
| 5490·92 | × |
| 5497·84 | × |
| 5501·61 | o |
| 5506·83 | × |
| 5512·49 | |
| 5514·68 | × |
| 5517·51 | |
| 5520·97 | |

* denotes that the line was measured on one plate only.
B denotes hypothetical bright lines.

only plate on which they can be measured, and their wave-lengths may be liable to errors amounting to 0·25 λ. Only one of them seems to be a Sun-spot line.

In their paper, *Astroph. Jour.*, xxiii. 400–405, Hale and Adams give the wave-lengths of lines in the spectrum of *α Orionis* from λ = 5393–5703. Out of 25 lines given by Hale and Adams, all but three can be identified; and three lines appear which are not given by them. The three lines which cannot be identified are 5393·36, 5407·62, 5418·99. The first is a very doubtful spot line, the second is a line much intensified in spots, the third is not intensified in spots. According to Hale and Adams, the first is a strong line in the star spectrum, the second is a fairly strong line, and the third is weak. The absence of the first two lines is remarkable, and suggests the possibility of change in the spectrum of the star.

Of the three lines not given by Hale, 5520·97 is the strongest, though it is only just measurable: the other two are very weak and not measurable; their approximate wave-lengths are 5449 and 5474.

## *Flutings in the Green Region of the Spectrum of α Orionis.*

Measures have been made of the wave-lengths of two absorption flutings sharp on the violet side and fading off towards the red; the heads of these two are at 5166·8 and 5447·1. The first of these flutings is the more marked, possibly on account of the fact that the lines $b_4$ and $b_3$ are involved near the head. The second also has a line at its head, whose wave-length is given in the table. According to Professor Fowler, the wave-lengths of the heads of the two strongest titanium flutings are 5167·5 and 5447·0, and their intensities he gives as 10. There seems little doubt then that the two flutings in *α Orionis* are titanium flutings. There are in this region 5 other titanium flutings, whose wave-lengths and intensities are given by Fowler, namely:

| | |
|---|---|
| 5241·0 | intensity 5 |
| 5308·0 | 3 |
| 5356·6 | 4 |
| 5407·0 | 1 |

All of these are to be found in the spectrum of *o Ceti*, but there is no certain indication of their presence in *α Orionis*.

*On the Presence of Tin in Stellar Atmospheres.* By Joseph Lunt, B.Sc., F.I.C., Assistant at the Royal Observatory, Cape of Good Hope.

During the course of measurements of stellar radial velocities, Mr A. W. Goatcher happened to measure a line at $\pm \lambda$ 4525 on 14 negatives of the spectrum of α Scorpii. He pointed out that the line in question was markedly discordant, giving a velocity which was more than 6 kilometres per second too low (positive) in the mean, when the wave-length of the stellar line was assumed to be λ 4525·285, corresponding to a blend of the two lines in Rowland's tables at λ 4525·110 Int 0, origin unknown, and λ 4525·314 Int 5, due to iron.

On searching for some cause for this pronounced discrepancy, I found that a strong tin line occurred on the ultra-violet side of the iron line.

Exner and Haschek place its wave-length at λ 4525·00 Int 30, and they give another line at λ 4585·80 Int 20, but they record no other lines brighter than intensity 1 in the region covered by the Cape 4 prism spectrograph.

On taking photographs of the spectrum of tin, with electrodes of the pure tin "fuse wire" ordinarily used in electrical circuits, it was found that whilst the λ 4525·00 line came out strongly, the λ 4585·80 line was entirely absent, and in fact no other line appeared except a faint line at λ 4227 due to a trace of calcium.

This was due to the fact that self-induction was used in the secondary circuit of the 18-inch spark induction coil, as is usual in producing the iron spark as a source of the comparison spectrum for our stellar spectra.

On eliminating the self-induction, the λ 4585·80 line came out much more strongly than the λ 4525·00 line, differing in this respect from Exner and Haschek's relative intensities; but with the exception of air lines no other lines of importance appeared.

The line of lower refrangibility is, in fact, the strongest enhanced line of tin recorded by Lockyer, whilst the λ 4525 line is absent from his list of enhanced lines.

It is evident that the λ 4585 line is not likely to occur in the cooler stars such as α Scorpii, and we are reduced to a single line in our 4-prism region in searching for evidence of the presence of tin in these stars.

The tin line from the "fuse wire" was carefully measured and gave the wave-length λ 4525·01, which shows that it is more likely to coincide with Rowland's solar line λ 4525·009 Int 00 than with the line closer to the iron line, viz. λ 4525·110 Int 0.

If we assume that the Sn and Fe lines have the intensities 3 and 4 respectively in α Scorpii instead of 00 and 5 as in the Sun, and wave-lengths λ 4525·009 and λ 4525·314, according to Rowland's solar wave-lengths, we can well represent the stellar line, which as a blend would then have the mean wave-length λ 4525·183.